18 February 2011

Tom Jenkins, Chair
Expert Panel on Review of Federal Support to Research and Development
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Re: Perspectives from TRIUMF on Federal Support for R&D

Dear Chairman Jenkins:

We are writing to provide input to your Expert Panel about Federal Support to Research and Development from the perspective of a national laboratory. We believe that national research laboratories play a crucial role in the innovation process by providing neutral territory for the coming together of talent, resources, and opportunities of the academic and private sectors. We believe that stimulating interactions between these two sectors through the national laboratories may expand business R&D in Canada.

Background
As Canada's national laboratory for particle and nuclear physics, TRIUMF derives nearly all of its science and technology programs from accelerators. The laboratory tackles the most compelling questions solvable by accelerators in particle physics, nuclear physics, nuclear medicine, and materials science in an international context. TRIUMF is a bridge from basic research to commercialization and economic growth; it is a driving force for innovation and commercialization that affects the economy, healthcare, and the environment. In the last decade, TRIUMF stimulated nearly $1 billion of economic activity.

TRIUMF is owned and operated as a joint venture by a consortium of 16 Canadian universities. Core operating funds are provided by the Government of Canada via a contribution agreement through National Research Council Canada in five-year cycles. Additional funding for research comes from CFI, CIHR, NRCan, NSERC, and WD with building capital funds provided by the Government of British Columbia.

As a national laboratory, TRIUMF provides research infrastructure and tools that are too large and complex for a single university to build, operate, or maintain. Its mission is:

- To make discoveries that address the most compelling questions in particle physics, nuclear physics, nuclear medicine, and materials science;
- To act as Canada's steward for the advancement of particle accelerators and detection technologies; and
- To transfer knowledge, train highly skilled personnel, and commercialize research for the economic, social, environmental, and health benefit of all Canadians.

Consultation Questions
Below, we include responses to a selected number of the consultation questions.

2. Does Figure 2, the model of business innovation presented above, capture the key structural factors and inputs to innovation? If not, what is missing?

The Canadian Council of Academies model is a good model for the process of business innovation. As discussed in their report and your Consultation Paper, the lack of a "climate for innovation" and "receptivity to innovation" contributes to Canada's poor performance in business-led commercialization of R&D. We would argue that a critical element for creating and fostering the climate (or appetite) for innovation is causing and facilitating dialogue between the university-research and private-industry sectors. Strictly speaking, a process model does not need to acknowledge where the process takes place or what catalyzes it. However, this begs the question of how popular or widespread the process actually is.

In our experience, a national laboratory with good networks and open-access policies provides a fertile environment for business innovation to get started. That is, when businesses frequently and informally intersect with academic research, the likelihood of a firm choosing innovation as a business strategy greatly improves. Most businesses get started with one or two ideas and tunnel vision is then required to get them from the garage to full-market penetration. By interacting with a laboratory, businesses are exposed to the broader spectrum of technologies and skills ancillary to their original product.

For instance, with TRIUMF's long history of medical-isotope production with Nordion and strong academic connections to the UBC Department of Chemistry, it was natural for Nordion to return to TRIUMF and its research partners to develop new radiochemical products in a cost-shared approach that took advantage of the NSERC CRD program. A preliminary patent on a new product has just been filed. Likewise, General Electric came to TRIUMF with a collaborative development proposal because of our involvement in the research and commerce of medical isotopes.

4. Regarding ideas and knowledge, do you believe it is important for Canadian firms to perform their own R&D and, if so, what do you believe are the key factors that have been limiting business R&D activity in Canada?

Businesses need to perform some of their own R&D. We are not in the golden age of the last century where monolithic corporations could afford elite research labs that drove breakthrough after breakthrough from the lab bench to the marketplace. More and more, the model for big-business innovation and product development is to partner with the best teams around the world. For instance, General Electric's medical-cyclotron division based in northern Europe came to TRIUMF in Canada in 2009 to discuss options for partnering on the development of a third-generation cyclotron that would be unit-sized and operate at the push of a button on a table-top.

Today's world separates "pre-competitive R&D" and "competitive R&D" where the "R" in the latter is much less than the "D." Pre-competitive R&D takes place before high-value intellectual property is developed and is typically performed in a collaborative partnership. Because pre-competitive R&D has shared benefits, it typically uses shared resources and shared talents with regular participation of public funds. Businesses regularly seek competitive leveraging of their funds with public monies on their topics of interest.

The next two steps after precompetitive R&D are tricky: (1) Determining when the research is moving into competitive technology development and (2) Performing the competitive R&D. The first person to say that a technology is ready for field testing and commercialization is likely the academic; the last person to say that a technology is ready for market analysis and commercialization is likely the business partner. In between these extremes is the so-called "valley of death." Pitched in these terms, however, the challenge is not just technological—it is one of communication and understanding. The second tricky part, performing the R&D in an IP-protecting fashion that respects the proprietary nature of the work, is more feasible and usually requires a high degree of

focus. Experience is the best teacher here and thus businesses engaged in R&D need to mix with each other as well academia.

Businesses need to be involved in performing their own proprietary R&D and in partnering with selected teams on it. This capability allows them (a) to stay abreast of the market and even develop their own forecasting abilities, and (b) to more quickly deploy new technologies and products. Today's globalized world doesn't allow much time for "catch up." If the competition releases a new product or feature, depending on the industry, you have six months or even just six days to respond.

We assert that a key barrier limiting business R&D in Canada is simply uncertainty and unfamiliarity. Businesses that are not familiar with the culture, pace, and research topics in academic R&D are unlikely to jump into strategic partnerships with basic-research institutions. (see next question)

5. Regarding networks, collaborations and linkages, what are the main impediments to successful business-university or business-college partnerships? Does the postsecondary education system have the right capacity, approaches, and policies for effective partnerships with business?

Businesses know too little about academic research and researchers and academic institutions know too little about businesses and businesspeople. Some institutions have championed the notion of a university as a primary driver of economic productivity; the challenge for this approach is that it encourages universities to enter into discussions with business on promising R&D projects with a "What's in it for me, by tomorrow?" attitude. This can undermine the premise of the relationship. Inventers and innovators should, of course, be compensated for their contributions, but academic institutions need to be clear on their primary objectives. A business is typically putting hard-earned or personal resources into a prospective R&D project and therefore has a very precautionary approach that is driven more by "keeping the lights on while taking a small risk" and less by the long-term potential for high-value product development. Likewise, most businesses don't have a full appreciation for how research progresses from idea to invention and then to deployment with academic partners.

In Canada, the national laboratories and several public-sector programs (e.g., CECRs) are becoming more effective at lowering this initial barrier to relatedness and understanding. Laboratories are in regular communication and contact with businesses as vendors, customers, and sponsors. Businesses work with engineers and technical staff at laboratories to build and deliver one-of-a-kind equipment and often have informal consultations with key laboratory staff about new product ideas or performance constraints. Academic researchers relate to laboratories as meeting grounds and expert resources for technical projects. Driven by budgets and promised milestones, laboratories deliver progress and performance on a schedule. Taken together, these attributes can make national laboratories a natural nexus for businesses and universities to get to know each other and to work alongside one another.

Instead of competing with universities and industry as Bell Labs once did, national labs should work toward collaboration across the continuum of research and industry. Universities provide the expertise in the form of faculty scientists and students while industry provides the demand for a particular innovation. Corporations are notoriously risk-averse and tend to shy away from high-risk, costly investment projects that do not produce quick, profitable results. The academic community presents its own roadblocks with a culture of "publish or perish." There is a need for large, unique facilities that conduct research in a directed way. National labs can serve as the Bell Labs of the future.

6. Regarding the creation of demand for business innovation, what role, if any, do you believe that government should play in being a "first customer" for R&D investments in Canada?

Government participation as a "first customer" can be pivotal to mobilizing knowledge transfer and creating successful commercialization. As an example, TRIUMF developed a crucial partnership with a small electron-beam welding company in Richmond, BC, to design and deliver a next-generation technology for accelerators called superconducting radio-frequency cavities. Capability and experience with this technology exists at only four other industrial firms in the world. TRIUMF chose this technology for the second phase of its isotope accelerator (ISAC-II) and pooled time, energy, and resources with PAVAC to build a local manufacturing capacity for these devices. In April 2008, the first Made-in-Canada cavity was successfully produced. TRUMF then purchased 20 of these devices to complete its accelerator. PAVAC is now selling its technologies and products to laboratories in Korea, India, and the U.S. Because TRIUMF served as partner in the knowledge transfer stage as well as the "first customer," PAVAC judged that the business risks were sufficiently mitigated that their investments were warranted. The result is a global success story and puts Canadian high-tech industry amidst the world's best in the multi-billion dollar industry of particle accelerators.

In another example within Canada, the Natural Resources Canada program for Non-reactor-based Isotope Supply Contribution Program (NISP-PPIN) identified specific a performance gap in present-day technologies and offered competitively awarded public-sector dollars. Various groups from around the country teamed up with private-sector partners to address the challenge and four groups were successful in the selection process. Although this program does not guarantee the Government of Canada as a "first customer" of the accelerator-based technologies for producing conventional medical isotopes, the role of the Government in identifying the technology gap as one of critical national importance stimulated business-led and university-led R&D activity. One of the successful groups is led by a BC company and two others are led by national laboratories. This is not a coincidence.

13. Are there any gaps in the Government of Canada's support to business and commercially-oriented R&D? Do firms performing R&D in other countries have an advantage over Canadian firms because of access to programs that are not available in Canada? What would be the principal features of new programming to fill these gaps?

Within the somewhat narrow scope of our thesis, the chief gap in Government of Canada's programming for facilitating business-led R&D is in stimulating conversation and exchange of personnel between academia and the private sector. National labs are part of the answer. The primary determinant of the success of spin-off companies from TRIUMF has been who the founding team knows in the industry. D-Pace, Inc., in Nelson, BC, winner of the 2007 NSERC Synergy Award for Innovation, has been successful because one of the principals left TRIUMF with an excellent understanding of the different companies and market sectors that could benefit from the technology he licensed.

Analysis shows that a good number of the entrepreneurs in Canada are in the ICT sector, a sector that could be said to have less structure, embedded hierarchy, and supply chains than manufacturing or high-tech equipment services (although this situation is changing as ICT is driven by high-performance distributed performance). To bring innovation to market in these other sectors requires a new level of connection and understanding of the industry. Programs that bring R&D performers and potential "innovation receptors" together on a frequent, informal basis are an ideal solution. At present, the dominant personnel exchange between TRIUMF and the private sector is through the large number of students who work at TRIUMF, graduate, and then take jobs in business.

15. Is there a difference between R&D and innovation? If yes, how are they different? Should government focus on R&D or Innovation? What should the balance be?

The glib answer is perhaps the simplest, most honest, and accurate: Yes and Yes.

From the perspective of a national laboratory, R&D characterizes most of the activities around the site nearly every day of the year. Research to better understand the world around us as well as the systems within our bodies that govern health and disease and development to extend, improve, and enhance the tools, ideas, and systems used in that pursuit. Innovation, on the other hand, is distinguished as the solution of a problem that is in the way of fulfilling on a particular goal: an innovative approach to quelling noisy ground planes on a preamplifier circuit-board that is used to study gamma rays from the decay of a rare isotope; designing and constructing an innovative jig to position a person's head in front of an extracted beam from the main cyclotron to enable therapeutic treatment of human eye cancer using energetic and focused protons. In the laboratory environment, innovation is therefore distinguished by being in service of fulfilling a performance objective. The first measurement of a rare transition between energy states of an isotope is not in itself innovative although it may be a breakthrough in research and may have required a number of innovations to make it possible.

Also important to distinguish is "invention." Inventions are what drove the formation and success of so many of today's high-tech companies. Inventions are brand new ideas that move from concept to prototype to marketplace. Inventions usually come from individuals whether in academic institutions or garages. National laboratories are becoming resources for moving inventions from ideas to prototypes.

The challenge of a laboratory, then, is not only to identify which "innovations" have potential interest in the private sector but also to identify which markets present opportunities for technology to be developed and commercialized. In the best of worlds, private-sector partners are involved in both types of activities and would provide the crucial guidance, market analysis, and ultimately deployment and distribution of the product.

As outlined in the preamble of the Consultation Paper, there is a strong rationale for public support of business R&D. We would argue that because of the murky transition between R&D and innovation, government must support some of both. Clearly, the generalized benefits and risks of basic research need to be handled by shared public investment. Pre-competitive R&D should be eligible for some public financing and as the proposed work moves from "Here's what we want to know" to "Here's something we want to build because it could be sold," the requirement for participation of industrial partners should be raised. At the critical transition, however, the government should be generous because business cannot afford to (in all senses of the word). That is, business will almost never reach across the "valley of death" to rescue and escort a technology into the marketplace. Government has to go at least halfway. In our experience, it is the existence of public funds for selected projects at the transition stage that encourage businesses to take part in an R&D venture.

In closing, we hope these comments have shed some light on the present and future roles of national laboratories in Canada's innovation system. We would be pleased to discuss these matters further.

Sincerely,

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Director

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